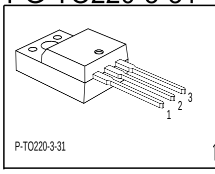
Cool MOS™ Power Transistor

V_{DS} @ T_{jmax}	560	V
$R_{DS(on)}$	0.95	Ω
I_D	4.5	A

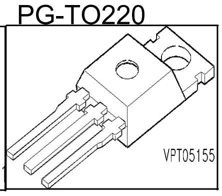
Feature

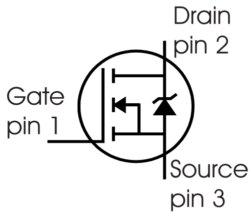
- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- Ultra low effective capacitances
- Improved transconductance
- PG-TO-220-3-31: Fully isolated package (2500 VAC; 1 minute)
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC[0)] for target applications

PG-TO220-3-31



PG-TO220





Type	Package	Ordering Code	Marking
SPP04N50C3	PG-TO220	Q67040-S4575	04N50C3
SPA04N50C3	PG-TO220-3-31	SP000216298	04N50C3

Maximum Ratings

Parameter	Symbol	Value		Unit
		SP	SPA	
Continuous drain current	I_D			A
T_C = 25 °C		4.5	4.5[1)]	
T_C = 100 °C		2.8	2.8[1)]	
Pulsed drain current, t_p limited by T_{jmax}	$I_{D\,puls}$	13.5	13.5	A
Avalanche energy, single pulse I_D=3.4A, V_{DD}=50V	E_{AS}	130	130	mJ
Avalanche energy, repetitive t_{AR} limited by T_{jmax}[2)] I_D=4.5A, V_{DD}=50V	E_{AR}	0.4	0.4	
Avalanche current, repetitive t_{AR} limited by T_{jmax}	I_{AR}	4.5	4.5	A
Gate source voltage	V_{GS}	±20	±20	V
Gate source voltage AC (f >1Hz)	V_{GS}	±30	±30	
Power dissipation, T_C = 25°C	P_{tot}	50	31	W
Operating and storage temperature	T_j , T_{stg}	-55...+150		°C
Reverse diode dv/dt [7)]	dv/dt	15		V/ns

Maximum Ratings

Parameter	Symbol	Value	Unit
Drain Source voltage slope V_{DS} = 400 V, I_D = 4.5 A, T_j = 125 °C	dv/dt	50	V/ns

Thermal Characteristics

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Thermal resistance, junction - case	R_{thJC}	-	-	2.5	K/W
Thermal resistance, junction - case, FullPAK	R_{thJC_FP}	-	-	4	
Thermal resistance, junction - ambient, leaded	R_{thJA}	-	-	62	
Thermal resistance, junction - ambient, FullPAK	R_{thJA_FP}	-	-	80	
SMD version, device on PCB:	R_{thJA}				
@ min. footprint		-	-	62	
@ 6 cm^2 cooling area 3)		-	35	-	
Soldering temperature, wavesoldering 1.6 mm (0.063 in.) from case for 10s 4)	T_{sold}	-	-	260	°C

Electrical Characteristics, at T_j=25°C unless otherwise specified

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Drain-source breakdown voltage	$V_{(BR)DSS}$	V_{GS}=0V, I_D=0.25mA	500	-	-	V
Drain-Source avalanche breakdown voltage	$V_{(BR)DS}$	V_{GS}=0V, I_D=4.5A	-	600	-	
Gate threshold voltage	$V_{GS(th)}$	I_D=200µA, V_{GS}=V_{DS}	2.1	3	3.9	
Zero gate voltage drain current	I_{DSS}	V_{DS}=500V, V_{GS}=0V,				µA
		T_j=25°C	-	0.1	1	
		T_j=150°C	-	-	100	
Gate-source leakage current	I_{GSS}	V_{GS}=20V, V_{DS}=0V	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	V_{GS}=10V, I_D=2.8A				Ω
		T_j=25°C	-	0.85	0.95	
		T_j=150°C	-	2.3	-	
Gate input resistance	R_G	f=1MHz, open drain	-	1.4	-	

Electrical Characteristics

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Transconductance	g_{fs}	V_{DS}≥2*I_D*$R_{DS(on)max}$, I_D=2.8A	-	4.4	-	S
Input capacitance	C_{iss}	V_{GS}=0V, V_{DS}=25V, f=1MHz	-	470	-	pF
Output capacitance	C_{oss}		-	160	-	
Reverse transfer capacitance	C_{rss}		-	15	-	
Effective output capacitance,[5] energy related	$C_{o(er)}$	V_{GS}=0V, V_{DS}=0V to 400V	-	27	-	
Effective output capacitance,[6] time related	$C_{o(tr)}$		-	44	-	
Turn-on delay time	$t_{d(on)}$	V_{DD}=350V, V_{GS}=0/10V, I_D=4.5A, R_G=18Ω	-	10	-	ns
Rise time	t_r		-	5	-	
Turn-off delay time	$t_{d(off)}$		-	70	-	
Fall time	t_f		-	10	-	

Gate Charge Characteristics

Parameter	Symbol	Conditions	min.	typ.	max.	Unit
Gate to source charge	Q_{gs}	V_{DD}=400V, I_D=4.5A	-	2.2	-	nC
Gate to drain charge	Q_{gd}		-	10	-	
Gate charge total	Q_g	V_{DD}=400V, I_D=4.5A, V_{GS}=0 to 10V	-	22	-	
Gate plateau voltage	$V_{(plateau)}$	V_{DD}=400V, I_D=4.5A	-	5	-	V

[0]J-STD20 and JESD22

[1]Limited only by maximum temperature

[2]Repetitve avalanche causes additional power losses that can be calculated as P_{AV}=E_{AR}*f.

[3]Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm² (one layer, 70 µm thick) copper area for drain connection. PCB is vertical without blown air.

[4]Soldering temperature for TO-263: 220°C, reflow

[5]$C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS}.

[6]$C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS}.

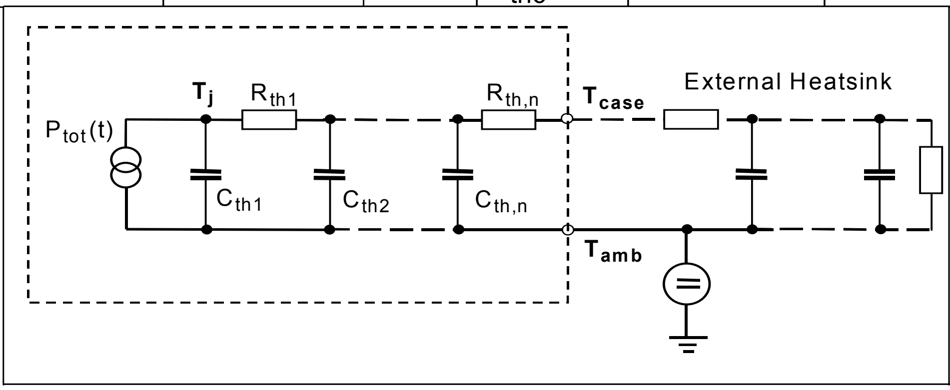
[7]I_{SD}<=I_D, di/dt<=400A/us, V_{DClink}=400V, V_{peak}<$V_{BR, DSS}$, T_j<$T_{j,max}$.
Identical low-side and high-side switch.

Electrical Characteristics

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Inverse diode continuous forward current	I_S	T_C=25°C	-	-	4.5	A
Inverse diode direct current, pulsed	I_{SM}		-	-	13.5	
Inverse diode forward voltage	V_{SD}	V_{GS}=0V, I_F=I_S	-	1	1.2	V
Reverse recovery time	t_{rr}	V_R=400V, I_F=I_S , di_F/dt=100A/µs	-	280	-	ns
Reverse recovery charge	Q_{rr}		-	2.3	-	µC
Peak reverse recovery current	I_{rrm}		-	16	-	A
Peak rate of fall of reverse recovery current	di_{rr}/dt	T_j=25°C	-	860	-	A/µs

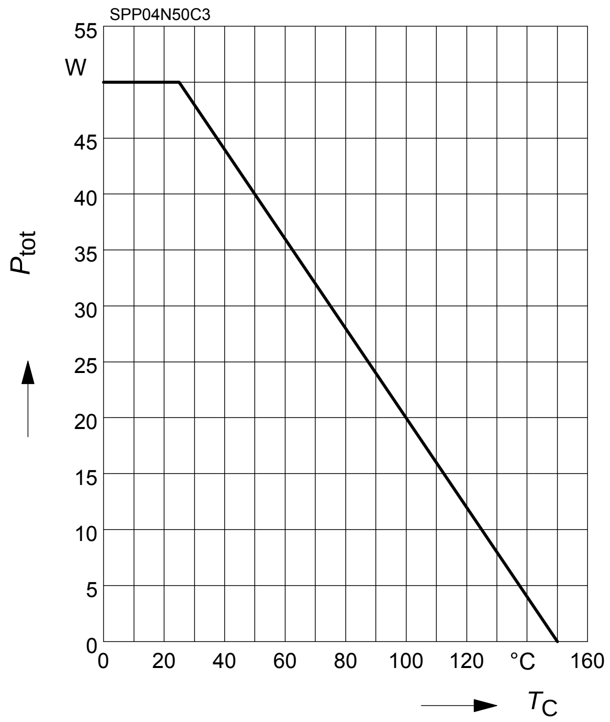
Typical Transient Thermal Characteristics

Symbol	Value		Unit	Symbol	Value		Unit
	SPP_B	SPA			SPP_B	SPA	
R_{th1}	0.039	0.039	K/W	C_{th1}	0.00007347	0.00007347	Ws/K
R_{th2}	0.074	0.074		C_{th2}	0.0002831	0.0002831	
R_{th3}	0.132	0.132		C_{th3}	0.0004062	0.0004062	
R_{th4}	0.555	0.272		C_{th4}	0.001215	0.001215	
R_{th5}	0.529	0.559		C_{th5}	0.00276	0.005633	
R_{th6}	0.169	2.523		C_{th6}	0.029	0.412	



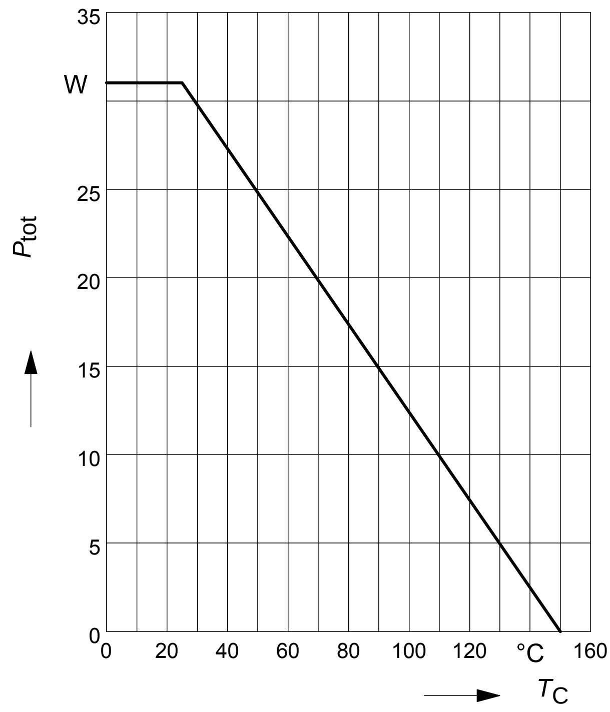
1 Power dissipation

$P_{tot} = f(T_C)$



2 Power dissipation FullPAK

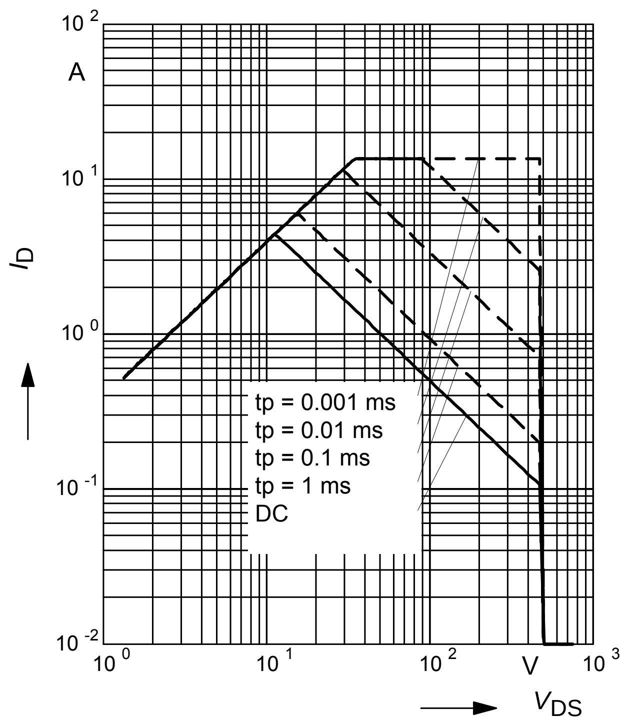
$P_{tot} = f(T_C)$



3 Safe operating area

$I_D = f(V_{DS})$

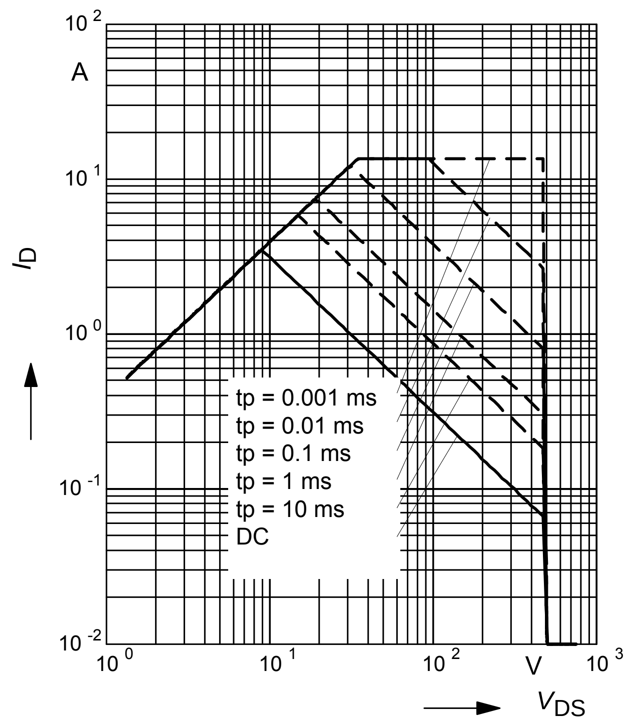
parameter : $D = 0$, T_C=25°C



4 Safe operating area FullPAK

$I_D = f(V_{DS})$

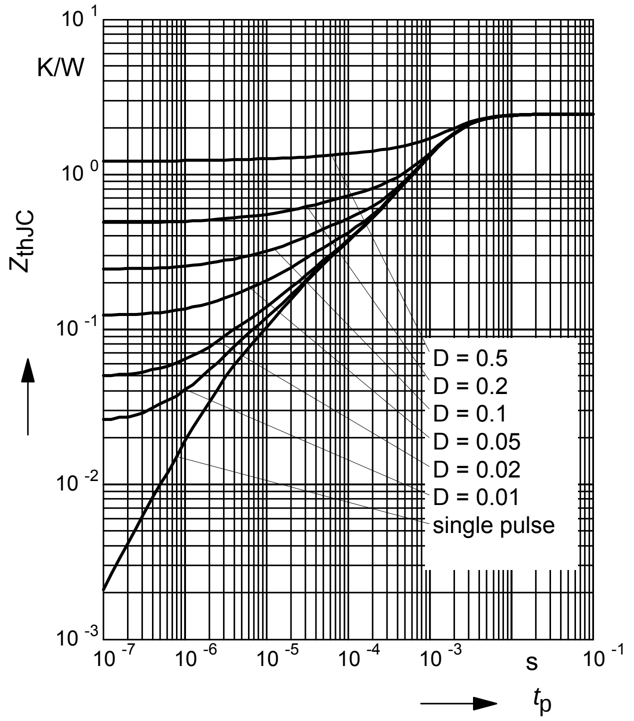
parameter: $D = 0$, T_C = 25°C



5 Transient thermal impedance

$Z_{thJC} = f(t_p)$

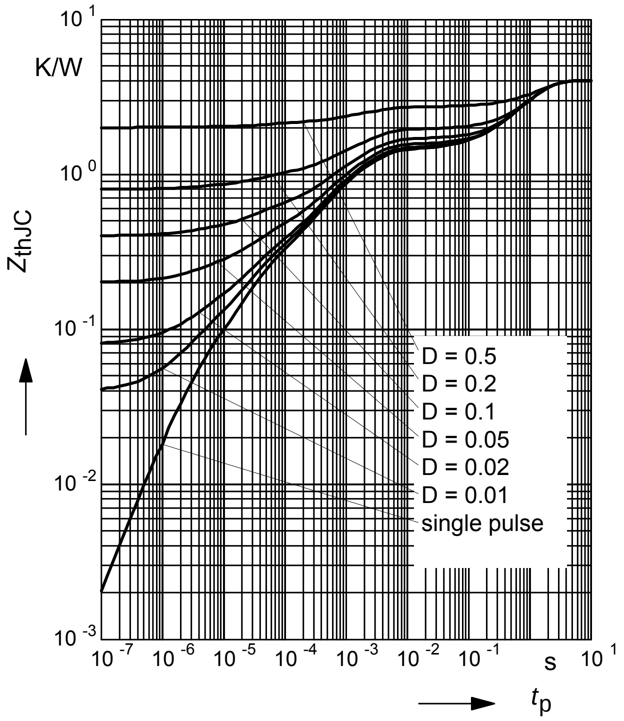
parameter: $D = t_p/T$



6 Transient thermal impedance FullPAK

$Z_{thJC} = f(t_p)$

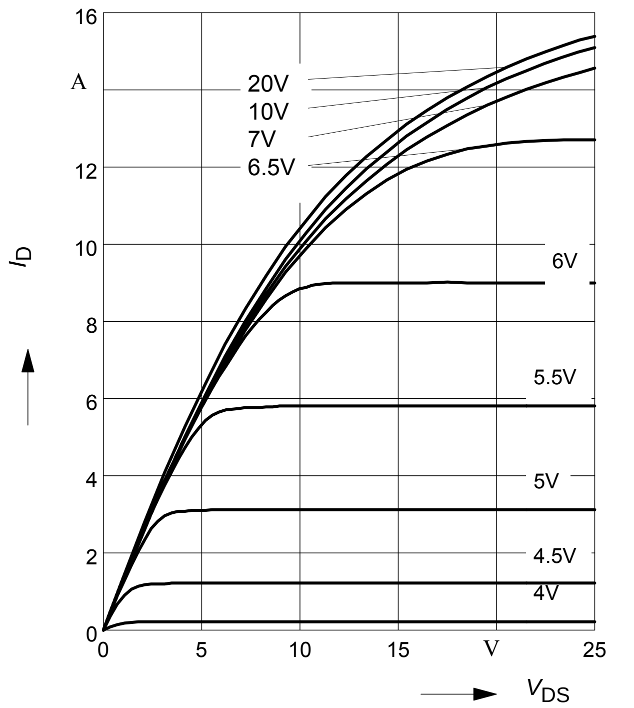
parameter: $D = t_p/t$



7 Typ. output characteristic

$I_D = f(V_{DS})$; T_j=25°C

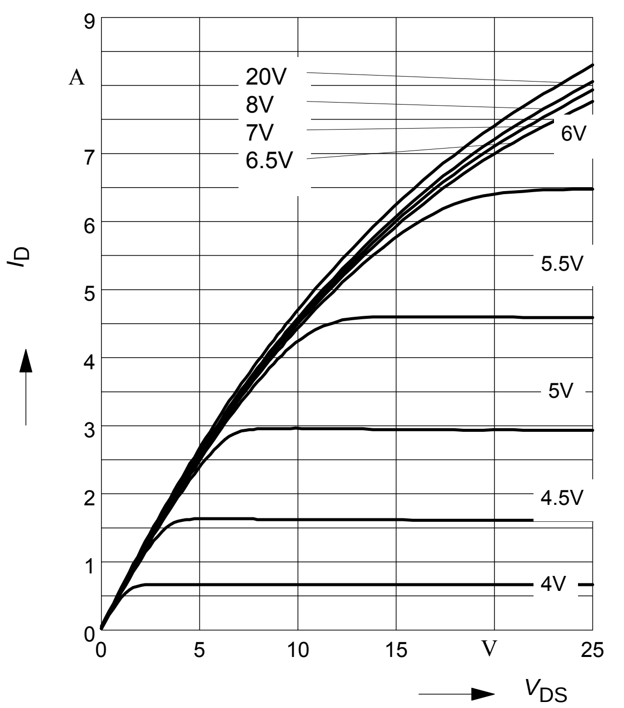
parameter: t_p = 10 µs, V_{GS}



8 Typ. output characteristic

$I_D = f(V_{DS})$; T_j=150°C

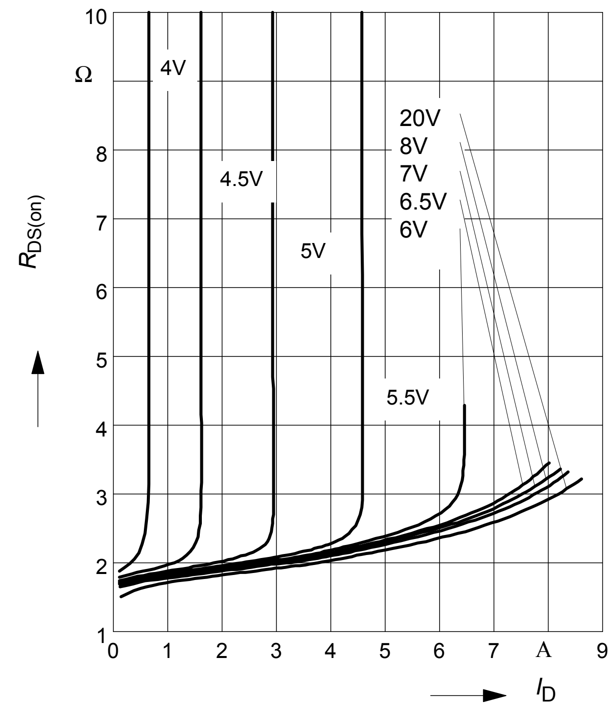
parameter: t_p = 10 µs, V_{GS}



9 Typ. drain-source on resistance

$R_{DS(on)}=f(I_D)$

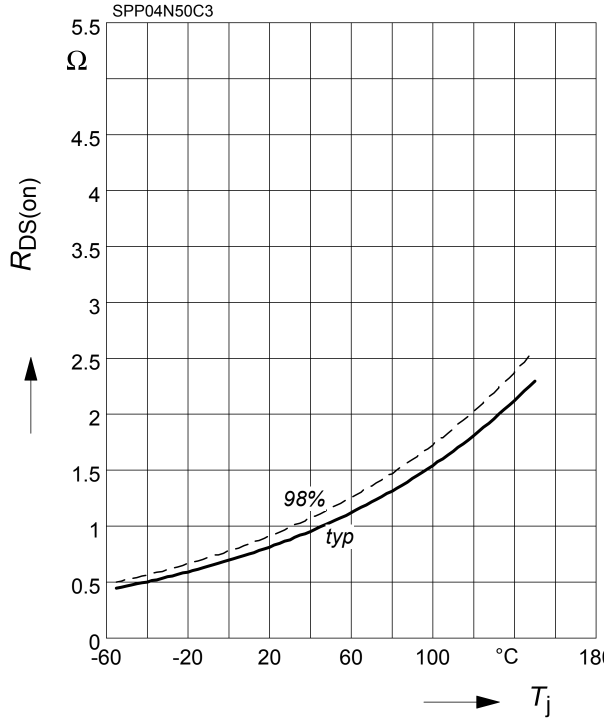
parameter: T_j=150°C, V_{GS}



10 Drain-source on-state resistance

$R_{DS(on)} = f\ (T_j)$

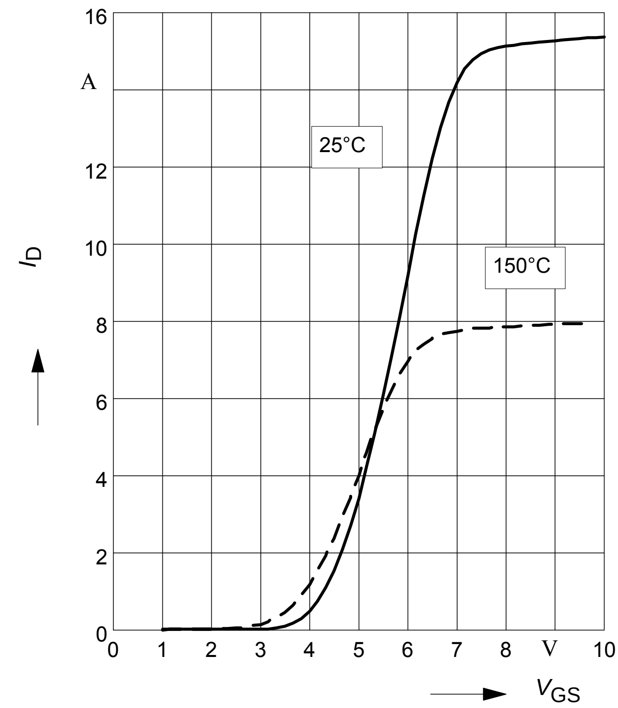
parameter : I_D = 2.8 A, V_{GS} = 10 V



11 Typ. transfer characteristics

$I_D= f\ (\ V_{GS}\ );\ V_{DS}\geq 2 \times I_D \times R_{DS(on)max}$

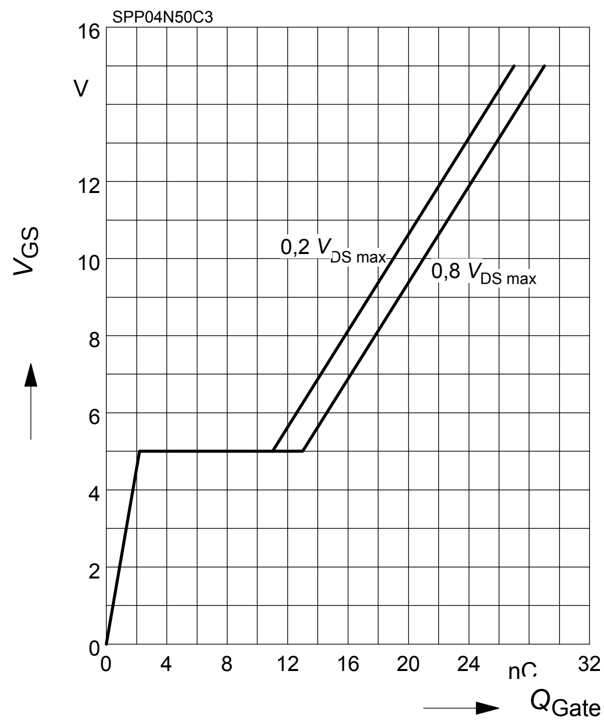
parameter: t_p = 10 µs



12 Typ. gate charge

$V_{GS} = f\ \ (Q_{Gate})$

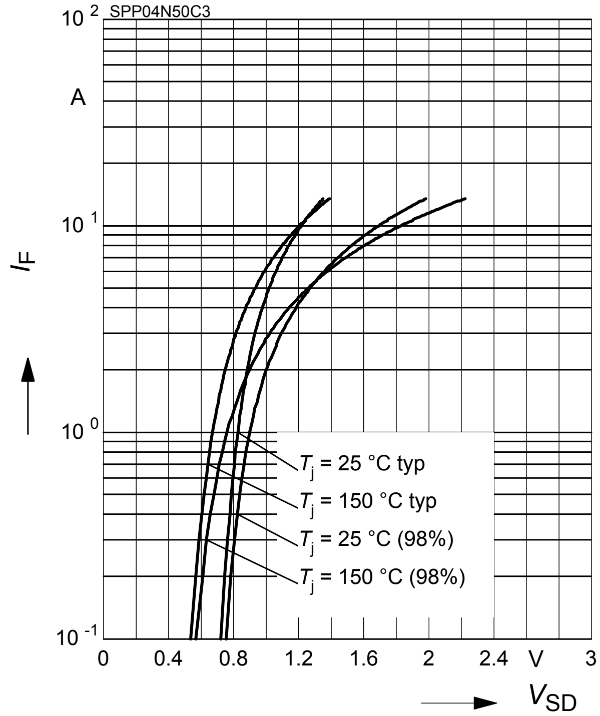
parameter: I_D = 4.5 A pulsed



13 Forward characteristics of body diode

$I_F = f(V_{SD})$

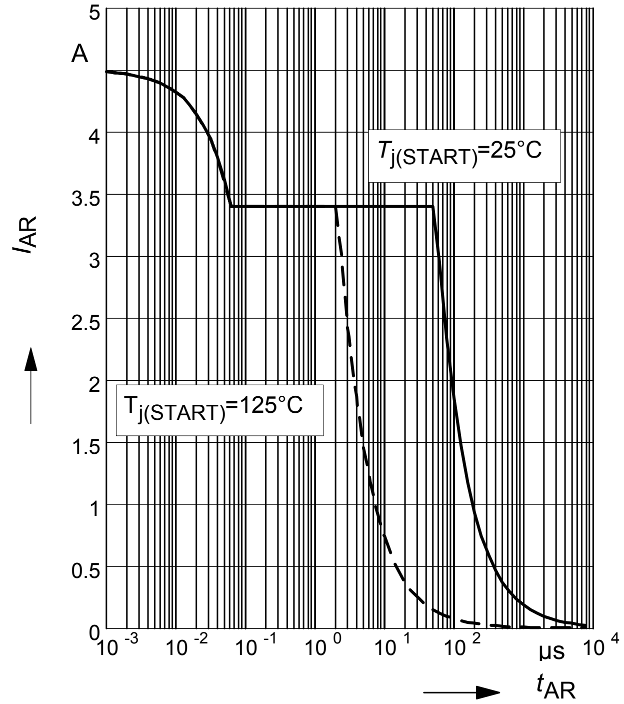
parameter: T_j , t_p = 10 µs



14 Avalanche SOA

$I_{AR} = f(t_{AR})$

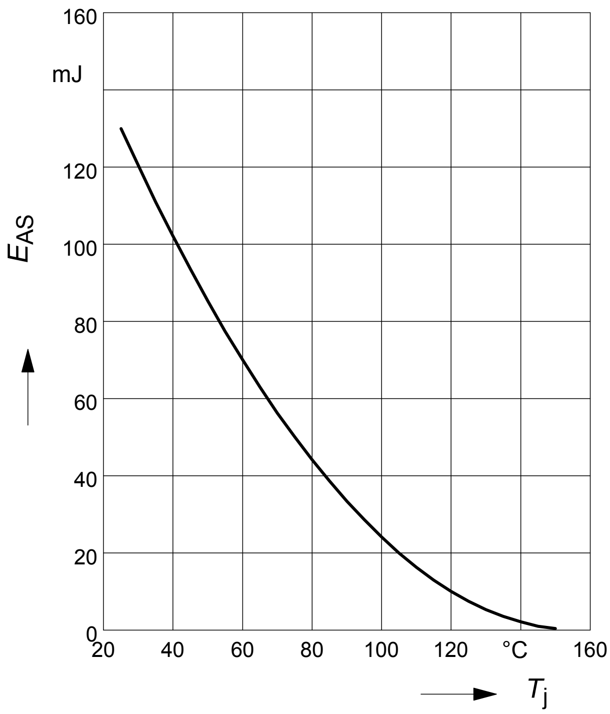
par.: $T_j \leq 150$ °C



15 Avalanche energy

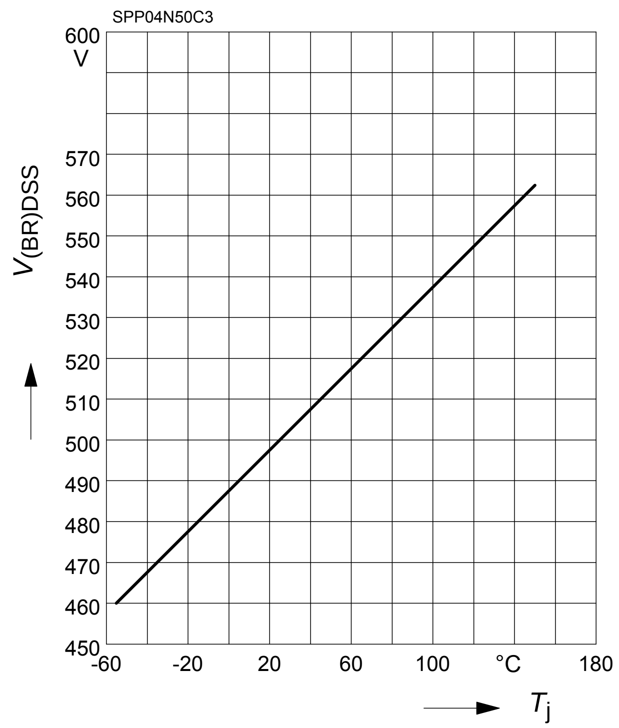
$E_{AS} = f(T_j)$

par.: I_D = 3.4 A, V_{DD} = 50 V



16 Drain-source breakdown voltage

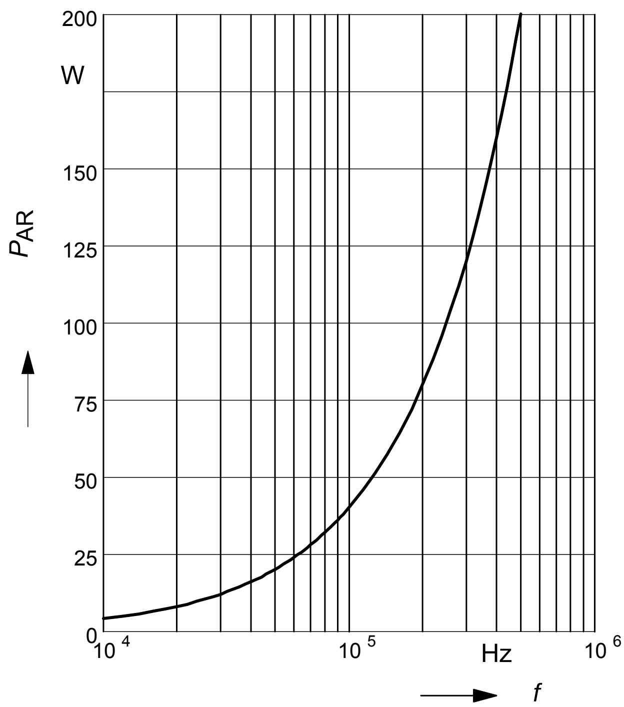
$V_{(BR)DSS} = f(T_j)$



17 Avalanche power losses

$P_{AR} = f(f)$

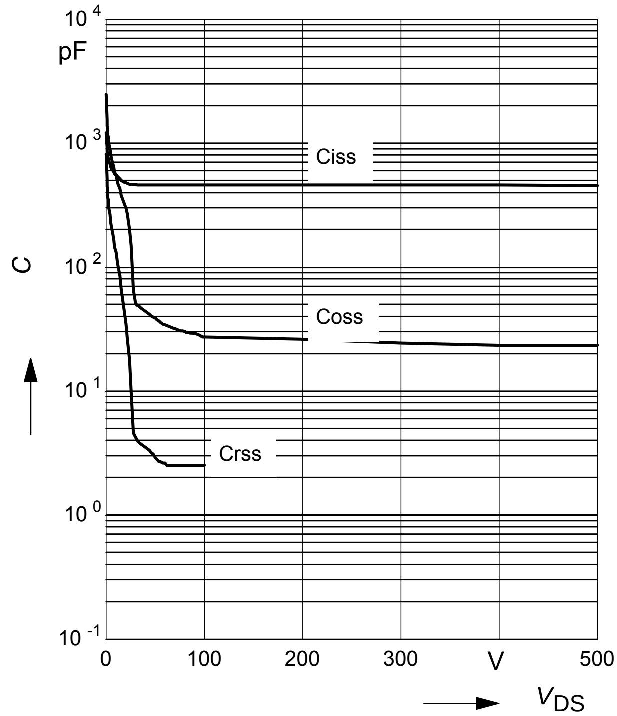
parameter: E_{AR}=0.4mJ



18 Typ. capacitances

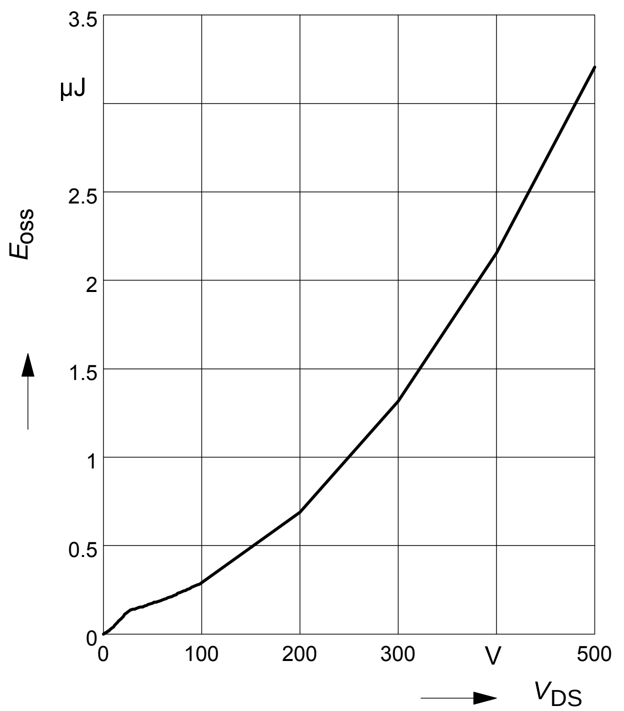
$C = f(V_{DS})$

parameter: V_{GS}=0V, f=1 MHz

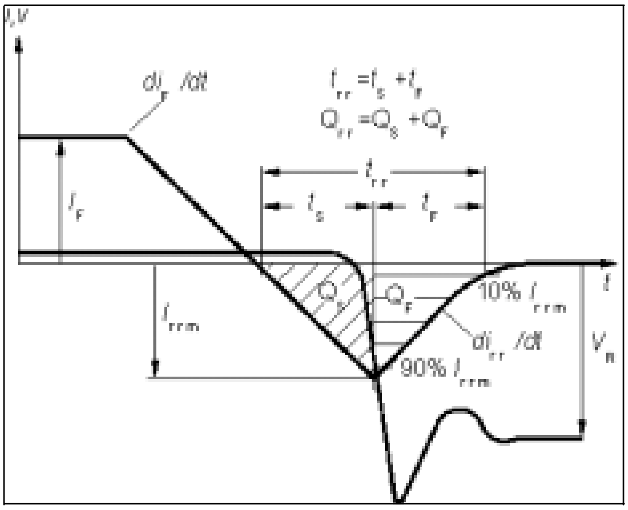


19 Typ. C_{oss} stored energy

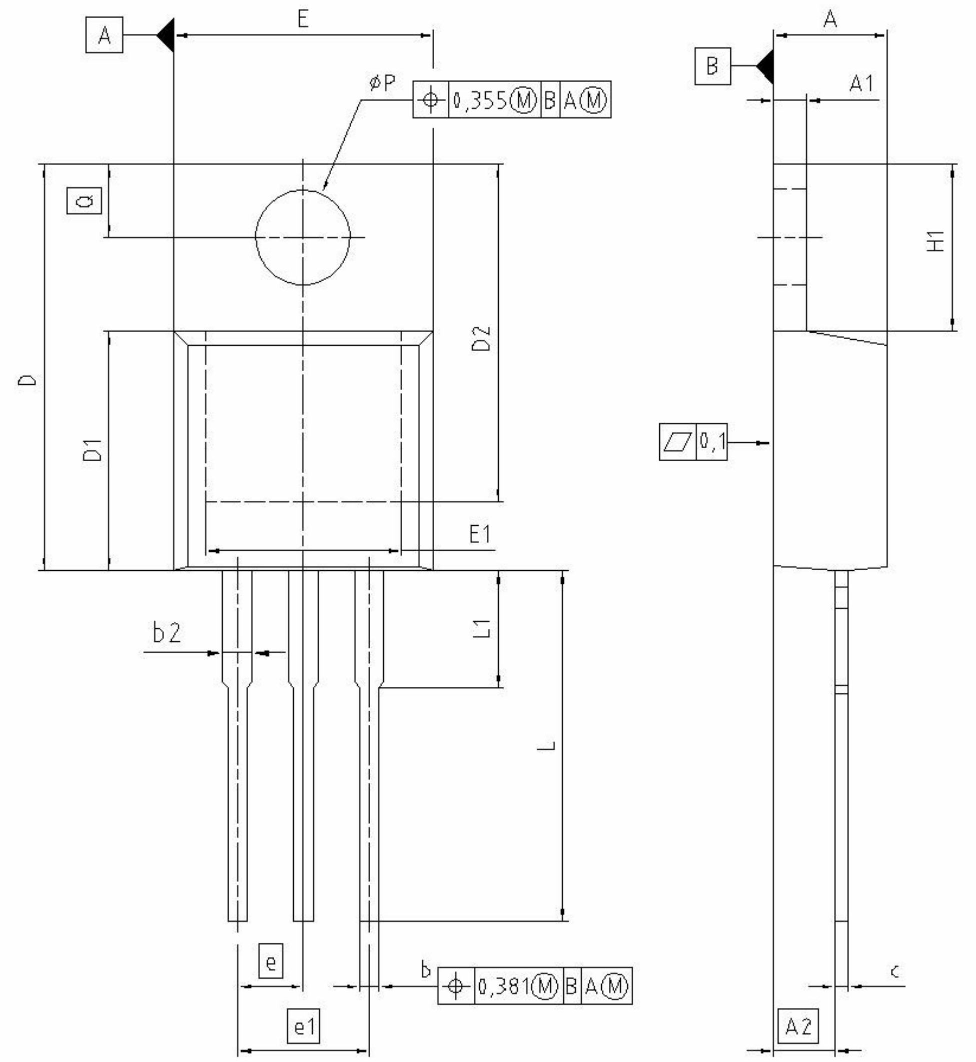
$E_{oss}=f(V_{DS})$



Definition of diodes switching characteristics

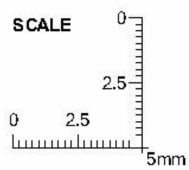


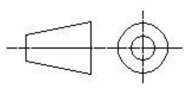
PG-TO220-3-1, PG-TO220-3-21



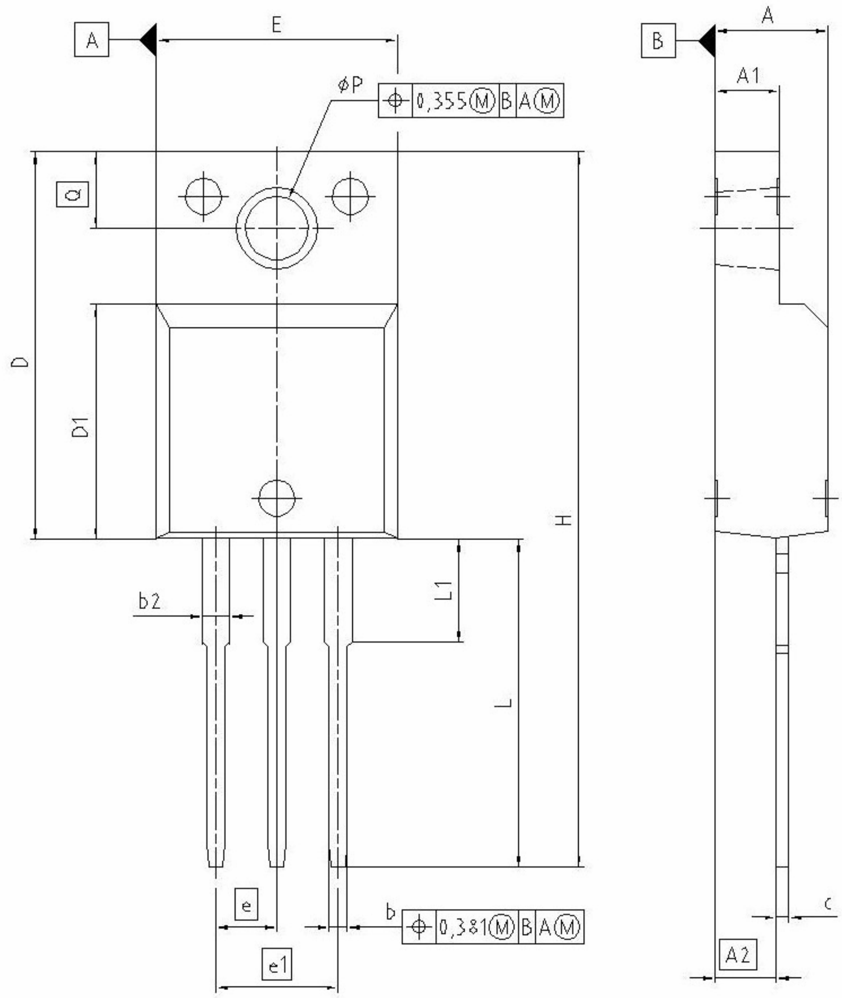
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.300	4.572	0.169	0.180
A1	1.170	1.400	0.046	0.055
A2	2.215	2.718	0.087	0.107
b	0.650	0.864	0.026	0.034
b2	0.635	1.778	0.025	0.070
c	0.330	0.600	0.013	0.024
D	14.808	15.950	0.583	0.628
D1	8.509	9.450	0.335	0.372
D2	12.850	13.100	0.506	0.516
E	9.700	10.363	0.382	0.408
E1	6.500	8.600	0.256	0.339
e	2.540		0.100	
e1	5.080		0.200	
N	3		3	
H1	5.900	6.900	0.232	0.272
L	13.000	14.000	0.512	0.551
L1	-	4.800	-	0.189
øP	3.700	3.886	0.146	0.153
Q	2.600	3.000	0.102	0.118

REFERENCE
JEDEC TO220
SCALE
EUROPEAN PROJECTION
ISSUE DATE 01-06-2005
FILE TO220_1





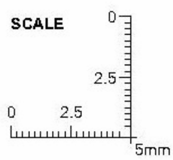
PG-TO220-3-31 (FullPAK)



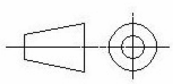
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.572	4.826	0.180	0.190
A1	2.573	2.827	0.101	0.111
A2	2.514	2.616	0.099	0.103
b	0.649	0.776	0.025	0.030
b2	1.143	1.509	0.045	0.059
c	0.449	0.627	0.017	0.027
D	15.863	16.117	0.624	0.634
D1	9.554	9.808	0.376	0.386
E	10.373	10.627	0.408	0.418
e	2.540		0.100	
e1	5.080		0.200	
N	3		3	
H	29.463	29.717	1.160	1.170
L	13.473	13.727	0.530	0.540
L1	3.175	3.429	0.125	0.135
øP	2.949	3.025	0.119	0.116
Q	3.149	3.251	0.124	0.128

REFERENCE
../..

SCALE



EUROPEAN PROJECTION



ISSUE DATE
17-08-2005

FILE
TO220_2

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